

# **EXHIBIT 12**

**David Autor, et al.,  
Concentrating on the Fall of  
the Labor Share**

Concentrating on the Fall of the Labor Share<sup>†</sup>By DAVID AUTOR, DAVID DORN, LAWRENCE F. KATZ,  
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There has been an upswing of interest in economics and the media over the decline in the share of GDP going to labor. The stability of the labor share of GDP was one of the famous Kaldor (1961) “stylized facts” of growth. The macro stability of labor’s share was always, as Keynes remarked, “something of a miracle” and disguised instability at the industry level (Elsby, Hobijn, and Sahin 2013). Karabarbounis and Neiman (2014) emphasize that the decline in the labor share is not confined to the United States and occurs primarily within rather than between industries. Although there is controversy over the degree to which the fall in the labor share is due to measurement issues such as the treatment of housing (Rognlie 2015) and intangible capital (Koh, Santaella-Llopis, and Zheng 2016), there is consensus that there has been a decline in the US labor share since the 1980s, particularly in the 2000s.

Nevertheless, little consensus exists on the causes of the decline in the labor share. Elsby, Hobijn, and Sahin (2013) argue for the importance of international trade and find that the labor share declines the most in US industries strongly affected by import shocks. However, labor shares have also declined in most nontraded

sectors such as wholesale, retail, and utilities, a pattern not readily explained by rising trade.

Karabarbounis and Neiman (2014) instead emphasize that the cost of capital has fallen relative to the cost of labor, driven especially by rapid declines in quality-adjusted equipment prices of information and communication technologies. A decline in the relative price of capital will lead to a decline in the labor share under CES production functions if the capital-labor elasticity of substitution is greater than unity. Although Karabarbounis and Neiman present evidence that the elasticity exceeds unity, the bulk of the empirical literature suggests a much lower elasticity (e.g., Lawrence 2015). Since changes in relative factor prices tend to be similar across firms, lower elasticity, i.e. below unity, lower relative equipment prices should lead to greater capital adoption and falling labor shares in all firms. In Autor et al. (2017) we find the opposite: the unweighted mean labor share across firms has not decreased much since 1982. Thus, the average firm shows little decline in its labor share. To explain the decline in the aggregate labor share, one must study the reallocation of activity among heterogeneous firms toward firms with low and declining labor shares.

In Autor et al. (2017) we propose a new *superstar firm* model that emphasizes the role of firm heterogeneity in the dynamics of the aggregate labor share. We hypothesize that industries are increasingly characterized by a “winner take most” feature where one firm (or a small number of firms) can gain a very large share of the market. Large firms have lower labor shares if production requires a fixed amount of overhead labor in addition to a size-dependent variable labor input, or if markups in the product market correlate positively with firm size. Possible explanations for the growth of winner take most include the diffusion of new competitive platforms (e.g., easier price/quality comparisons on the Internet), the proliferation of information-intensive goods that have high

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fixed and low marginal costs (e.g., software platforms and online services), or increasing competition due to the rising international integration of product markets. New technologies may also have strengthened network effects and favored firms that are more adept at adopting and exploiting new modes of production.

This paper expositis and evaluates two core claims of the superstar firm explanation: (i) the concentration of sales among firms within an industry should rise across much of the US private economy; and (ii) industries with larger increases in concentration should experience a larger decline in labor's share.

### I. Model

To see the intuition for a link between the rise of superstar firms and a decline in the labor share, consider a production function  $Y = AV^{\alpha_L} K^{1-\alpha_L} L$  where  $Y$  is value-added,  $V$  is variable labor,  $K$  is capital, and  $A$  is Hicks-neutral efficiency (TFPQ), which we assume is heterogeneous across firms. There is a fixed amount of overhead labor  $F$  needed for production, so total labor is  $L = V + F$ . We assume that factor markets are competitive with wage  $w$  and cost of capital  $r$  being equal to the input factors' marginal revenue products, while there is imperfect competition in the product market. From the static first-order condition for labor, we can write the share of labor costs ( $wL$ ) in nominal value-added ( $PY$ ) as

$$(1) \quad S_i = \left( \frac{wL}{PY} \right)_i = \frac{\alpha_L}{\mu_i} + \frac{wF}{(PY)_i},$$

where  $\mu$  is the markup, the ratio of product price ( $P$ ) to marginal cost ( $c$ ), and  $F$  is fixed overhead labor costs. The firm subscripts  $i$  indicate that for given economy-wide values of  $(\alpha_L, w, F)$ , a firm will have a lower labor share if (i) its share of fixed costs in total revenues is lower or (ii) its markup is higher. Superstar firms (firms with high  $A_i$ ) will be larger because they produce more efficiently and capture a higher share of industry output. Superstar firms therefore will have a lower share of fixed costs in total revenues, and thus a lower labor share. In monopolistically competitive models, the markup is the same across firms in an industry:  $\mu = \rho / (\rho - 1)$ , where  $\rho$  is the price elasticity of demand. However, in other models of

imperfect competition, firms with larger market shares will be able to set higher markups (e.g., Cournot competition), also leading to a negative relationship between firm size and labor shares. In either case, when there is an exogenous change that allocates more market share to a small number of large superstar firms, the aggregate labor share will fall as the economy shifts toward these low labor share firms. Autor et al. (2017) formalize this idea in a simple superstar firm model for a monopolistically competitive setting. Distinct from the prior literature, the superstar firm model emphasizes the heterogeneity of firms within industries as being critical for understanding the fall in the labor share. We next show that, in line with the model's mechanism, the concentration of sales across firms within industries has grown in most US sectors.

### II. Data and Empirical Findings

We use data from the US economic census, conducted every five years to enumerate all establishments in select sectors on current economic activity. We focus on the economic census from 1982 to 2012 for six large sectors: manufacturing, retail trade, wholesale trade, services, finance, and utilities and transportation. The covered establishments in these six sectors account for four-fifths of total private sector employment.

For the six sectors, the census reports each establishment's annual payroll, output, employment, and an identifier for the firm to which the establishment belongs. To measure the concentration of sales within an industry, we use an output measure capturing total sales by the establishment during the survey year. To measure sales at the firm level, we aggregate the sales of all establishments that belong to the same firm and the same industry. If a firm operates establishments in several industries, each combination of firm and industry is counted as a separate firm, capturing the firm's separate contributions to sales concentration in several industries.

To implement our industry-level analysis, we assign each establishment in a given year to a 1987 SIC-based time-consistent industry code as described in Autor et al. (2017). Our methodology yields 676 industries, 388 of which are in manufacturing. All of our measures use these time-consistent industry definitions leading to measures of industry concentration that differ slightly from published statistics. The

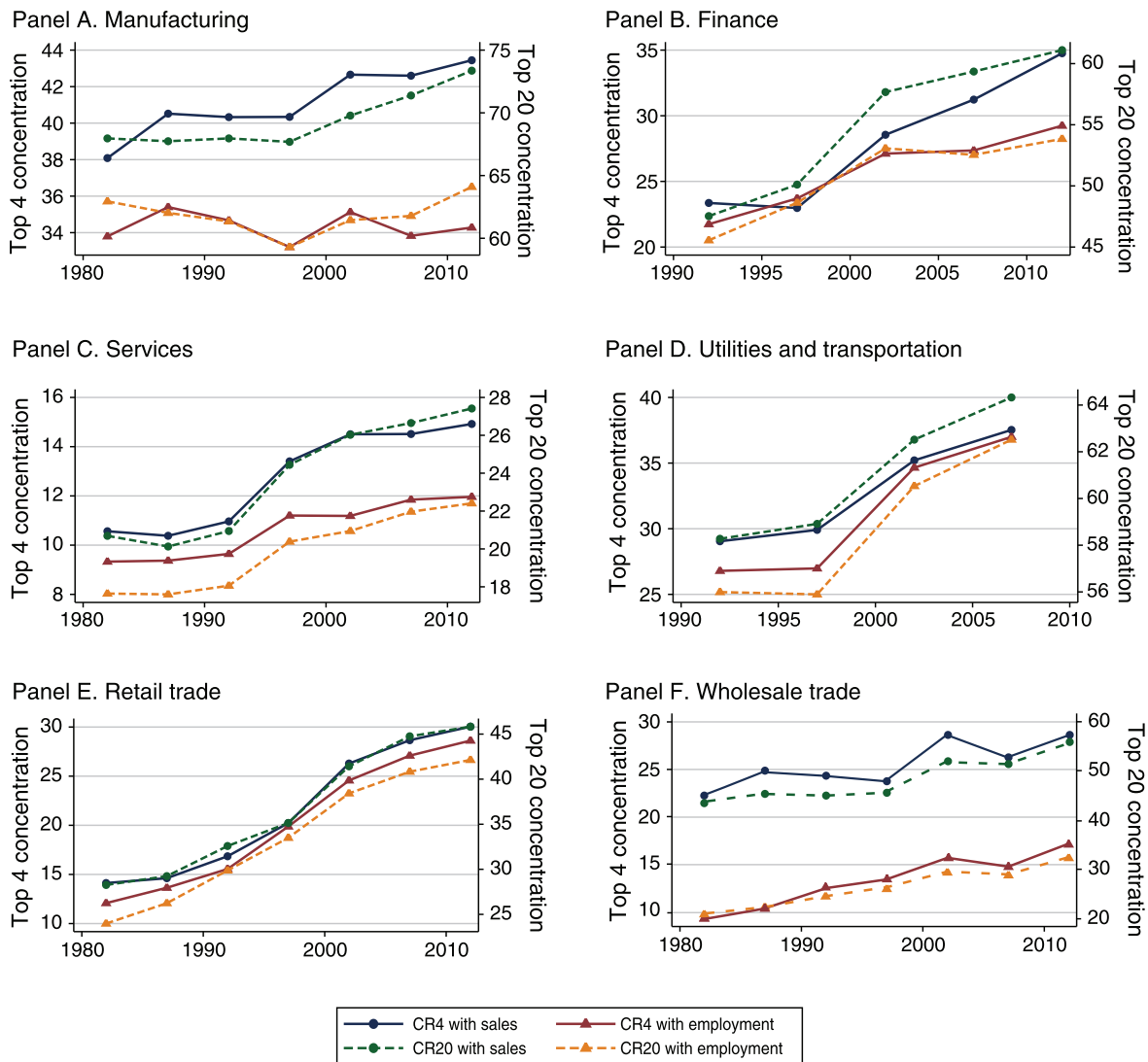


FIGURE 1. AVERAGE TOP 4 INDUSTRY CONCENTRATION BY MAJOR INDUSTRY GROUP

*Notes:* This figure plots the average concentration ratio in six major sectors of the US economy. Industry concentration is calculated for each time-consistent four-digit industry code as described in Autor et al. (2017), and then averaged across all industries within each of the six sectors. The solid line with circles, plotted on the left axis, shows the average fraction of total industry sales that is accounted for by the largest four firms in that industry, and the solid line with triangles, also plotted on the left axis, shows the average fraction of industry employment utilized in the four largest firms in the industry. Similarly, the dashed line with circles, plotted on the right axis, shows the average fraction of total industry sales that is accounted for by the largest 20 firms in that industry, and the dashed line with triangles, also plotted on the right axis, shows the average fraction of industry employment utilized in the 20 largest firms in the industry. Data for the financial sector in panel B and for utilities and transportation in panel D are available only since 1992.

correlation between our calculated measures and those based on the published data is close to one, however, for periods without changes in industry definitions.

We measure the concentration of sales within an industry as either the fraction of total sales accruing to its four largest firms (denoted CR4)

or the fraction of sales accruing to its 20 largest firms (denoted CR20). Figure 1 plots the average CR4 and CR20 across four-digit industries for our six sectors from 1982 to 2012. The level of sales concentration varies considerably across sectors. In each year, the top four firms in an average manufacturing industry capture more

than one-third of the industry's total sales, while the top four firms in the average service industry combine for less than one-sixth of total sales.

There is a remarkably consistent upward trend in concentration in each sector. In manufacturing, the sales concentration ratio among the top four increases from 38 percent to 43 percent; in finance, it rises from 24 percent to 35 percent; in services from 11 percent to 15 percent; in utilities from 29 percent to 37 percent; in retail trade from 15 percent to 30 percent; and in wholesale trade from 22 percent to 28 percent. Over the same period, there were similar or larger increases in CR20 for sales.

To further characterize the emergence of superstar firms, Figure 1 also plots CR4 and CR20 concentration measures based on firm employment rather than sales. Again, we observe a rise in concentration in all six sectors for 1982 to 2012, although employment concentration has grown notably more slowly than sales concentration in finance, services, and especially in manufacturing. The pattern suggests that firms may attain large market shares with a relatively small workforce, as exemplified by Facebook and Google.

In Autor et al. (2017) we show that the two main qualitative findings of Figure 1 are robust to the use of an industry's Herfindahl-Hirschman index (HHI). Sales have become more concentrated in each of the six broad sectors of the US economy.

A measurement challenge for our finding of rising concentration for broad US sectors is that our concentration measures are calculated exclusively using US-based establishments. Thus, our measures include production by foreign multinationals operating in the United States, but they exclude imports. A measure that includes only the market shares of US producers may mischaracterize concentration trends given rising import shares, particularly for manufacturing.

We assess the importance of trade in the competitive structure of manufacturing by calculating import-adjusted concentration ratios that treat imports from major country groups as if they belong to a single firm. Figure 2 plots the import-adjusted CR4 and CR20 measures along with the original measures only for US-based establishments. The series with and without trade adjustment track each other closely, reaffirming our main finding of rising sales

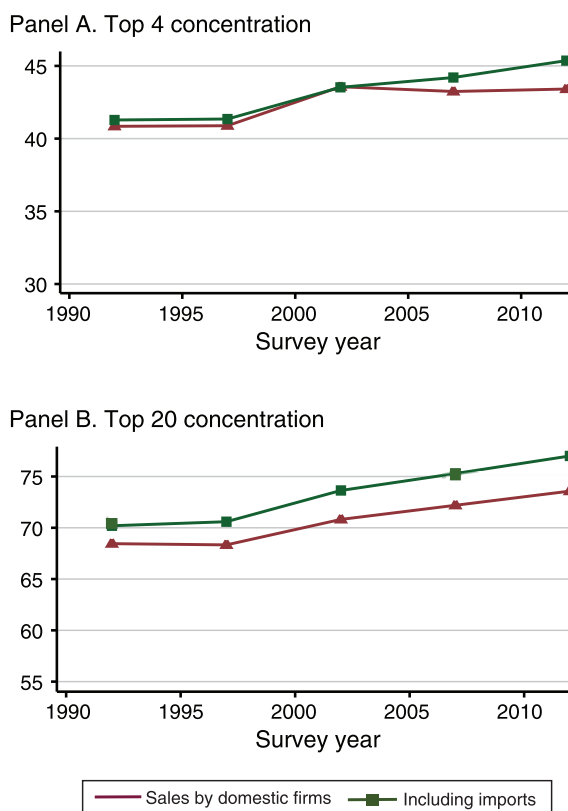


FIGURE 2. INDUSTRY CONCENTRATION ADDING IMPORTS

*Notes:* This figure plots the average sales concentration in US four-digit manufacturing industries from 1992 to 2012. The line with triangular markers the average fraction of total sales by domestic firms that is accounted for by an industry's four largest firms (corresponding to the CR4 Sales data series in the top left panel of Figure 1). The line with squares markers the fraction of the total US market, defined as sales by domestic firms plus industry imports, which is produced by an industry's four largest "firms", where each group of exporting countries is counted as an individual firm. Imports are based on UN Comtrade data as described in Autor et al. (2017), and the six country groups are: Canada, Mexico/CAFTA, China, low-income countries except China, eight developed countries (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland), and rest of the world. On average, 0.94 country groups are among the top four firms in panel A, and 2.7 country groups are among the top 20 firms in panel B.

concentration. The slightly higher level of the adjusted concentration ratios implies that foreign producers (such as China) account for a sizable fraction of sales in some manufacturing industries. Imports in such industries likely originate from a small number of major foreign firms, but our data do not permit a firm-level breakdown of imports.



A further implication of our superstar firm model is that the labor share should fall differentially in industries that are experiencing larger increases in concentration. Intuitively, the causal force in our model is the shift in competitive conditions, which reallocates market share to larger and more productive firms. Indeed, Autor et al. (2017) document a strong negative relationship in the cross section between a firm's market share and its labor share. Thus, rising concentration and falling labor shares should move in tandem, both in aggregate and between industries.

Autor et al. (2017) test this implication by estimating bivariate regressions of five-year changes in the payroll share of value-added on the contemporaneous change in concentration for the 388 manufacturing industries for the years 1987–2012. Figure 3 (sourced from Autor et al. 2017) summarizes these regressions. In the *initial* five years of our sample, we detect no significant cross-industry relationship between rising concentration and falling labor share. But the cross-industry relationship between rising concentration and falling labor share becomes negative and significant in the next five-year interval, and grows in absolute magnitude across each subsequent interval. In the final period from 2007 to 2012, we estimate that each percentage point rise in an industry's CR20 concentration index predicts a 0.4 percentage point fall in its labor share. We also observe a similar negative relationship between changes in the share of labor in sales and concentration in all six sectors.

Why has industry sales concentration increased? One set of explanations involves a technological change that has made markets increasingly “winner take most” so that superstar firms with higher productivity increasingly capture a larger slice of the market. Or if incumbents are more likely to innovate and the persistence of incumbent's innovative advantage has risen (Acemoglu and Hildebrand 2017), the incumbent advantage would increase and so would incumbents' market shares.

An alternative set of explanations posits that higher concentration could arise from anticompetitive forces whereby dominant firms are increasingly able to prevent actual and potential rivals from entering and expanding (Barkai 2016). For instance, firms may lobby for regulatory barriers that complicate market entry/expansion for new and small firms. Higher entry

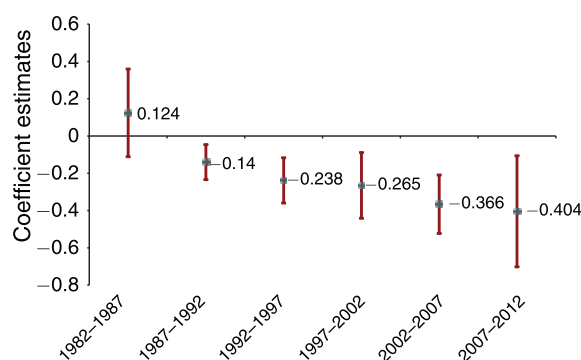


FIGURE 3. CORRELATION BETWEEN CHANGES IN LABOR SHARE AND CHANGES IN INDUSTRY CONCENTRATION IN THE US MANUFACTURING SECTOR AT FIVE-YEAR INTERVALS, 1982–1987 THROUGH 2007–2012

*Notes:* This figure plots point estimates and 95 percent confidence intervals from Autor et al. (2017) for ordinary least squares bivariate regressions of the change in the payroll to value-added share on the change in the CR20 index and a constant, estimated at the level of four-digit US manufacturing industries and separately for each of the indicated five-year intervals. Regressions are weighted by industries' shares of value-added in 1982.

barriers would enable incumbents to have higher monopolistic rents and therefore lower the labor share.

In the first set of explanations, the industries becoming increasingly concentrated will tend to be more dynamic with higher productivity and technical change. By contrast, in the second set of explanations, the concentrating industries are likely to be dominated by less productive and less dynamic incumbents.

To shed light on these alternatives, we explored the relationship between changes in concentration and changes in other industry characteristics. Data limitations restrict this analysis to manufacturing. We find that the industries that became more concentrated over our sample period were also the industries in which productivity—measured by either output per worker, value-added per worker, TFP, or patents per worker—increased the most. Interestingly, there is no strong relationship between the change in concentration and the change in average wages. The findings suggest that a positive productivity-concentration relationship will most likely feature in any plausible explanation of rising industry concentration.

### III. Conclusions

We have considered a *superstar firm* explanation for the much-discussed fall in labor share of GDP. Our hypothesis is that technology or market conditions—or their interaction—have evolved to increasingly concentrate sales among firms with superior products or higher productivity, thereby enabling the most successful firms to control a larger market share. Because these superstar firms are more profitable, they will have a smaller share of labor income in total sales or value-added. Consequently, the aggregate share of labor falls as the weight of superstar firms in the economy grows. The model yields many predictions that are elaborated and tested in Autor et al. (2017). A key underpinning of the superstar firm explanation for declining labor share is that sales should become increasingly concentrated in a small number of firms across a wide range of industries. Consistent with the model, we find that the concentration of sales (and of employment) has indeed risen from 1982 to 2012 in each of the six major sectors covered by the US economic census. In Autor et al. (2017), we further show that those industries where concentration rises the most have the sharpest falls in the labor share, and that the fall in the labor share is mainly due to a reallocation of labor toward firms with lower (and declining) labor shares, rather than due to declining labor shares within most firms.

### REFERENCES

- Acemoglu, Daron, and Nikolaus Hildebrand.** 2017. “Increasing Concentration and Persistence of Innovation: Facts and Theory.” <http://economics.mit.edu/faculty/acemoglu/paper>.
- Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen.** 2017. “The Fall of the Labor Share and the Rise of Superstar Firms.” <http://economics.mit.edu/faculty/dautor/policy>.
- Barkai, Simcha.** 2016. “Declining Labor and Capital Shares.” <http://home.uchicago.edu/%7Ebarkai/doc/BarkaiDecliningLaborCapital.pdf>.
- Elsby, Michael W. L., Bart Hobijn, and Aysegül Sahin.** 2013. “The Decline of the U.S. Labor Share.” *Brookings Papers on Economic Activity* (Fall): 1–42.
- Kaldor, Nicholas.** 1961. “Capital Accumulation and Economic Growth.” In *The Theory of Capital*, edited by F. A. Lutz and D. C. Hague, 177–222. New York: Stockton Press.
- Karabarbounis, Loukas, and Brent Neiman.** 2014. “The Global Decline of the Labor Share.” *Quarterly Journal of Economics* 129 (1): 61–103.
- Koh, Dongya, Raül Santaclotà-Llopis, and Yu Zheng.** 2016. “Labor Share Decline and Intellectual Property Products Capital.” Barcelona Graduate School of Economics Working Papers 927.
- Lawrence, Robert Z.** 2015. “Recent Declines in Labor’s Share in US Income: A Preliminary Neoclassical Account.” National Bureau of Economic Research Working Paper 21296.
- Rognlie, Matthew.** 2015. “Deciphering the Fall and Rise in the Net Capital Share: Accumulation or Scarcity?” *Brookings Papers on Economic Activity* (Spring): 1–69.
- Acemoglu, Daron, and Nikolaus Hildebrand.** 2017. “Increasing Concentration and Persistence